

HEP

SOLID-STATE DEVICE *and* PROJECT CATALOG

Effective November 1, 1966

This brochure contains the typical operating characteristics of Motorola's HEP semiconductor devices and a short description of some of the many projects that can be built around these devices.



MOTOROLA Semiconductor Products Inc.

TRANSISTORS

GERMANIUM PNP GENERAL PURPOSE

LOW POWER

Minimum Ratings and Characteristics (unless noted)									
HEP Type #	Collector-Base Voltage BV _{CBO} (Vdc)	Collector-Emitter Voltage BV _{CES} (Vdc)	Emitter-Base Voltage BV _{EBO} (Vdc)	Collector-Current I _C (mAdc)	Total Device Dissipation @ T _A = 25°C P _D (mW)	Operating Junction Temperature T _J (°C) Max	Typical Cut-Off Frequency f _{hfb}	Typical Current Gain h _{FE} (β)	Package Configuration
1	12	12	2	100	150	100	100 MHz	50	TO-18
2	22	10(ceo)	0.65	100	300	100	750 MHz	60	TO-5
3	20	20	0.5	50	100	100	250 MHz	85	TO-72
250	20	20	2.5	200	200	85	500 kHz	80	TO-5
251	20	20	2	200	200	85	500 kHz	120	TO-5
252①	20	20	2	200	200	85	500 kHz	80	TO-5
253	20	20	2.5	400	225	100	500 kHz	40	TO-5
254	20	20	2.5	400	225	100	500 kHz	70	TO-5

① Low leakage Transistor - 200 μAdc

MEDIUM POWER

200	30	30	10	3 A	90 W	110	600 kHz	40	TO-3
230	30	30	10	3 A	90 W	110	600 kHz	50	TO-3
232	70	70	10	7 A	90 W	110	600 kHz	60	TO-3

HIGH POWER

231	30	30	10	15 A	150 W	110	500 khz	40	TO-36
233	65	65	60	15 A	150 W	110	500 kHz	55	TO-36

TRIGGER

Maximum Ratings and Characteristics (unless noted)							
HEP Type #	Average Power Dissipation T _A = 25°C P _(AV) (mW)	Peak Forward Pulse Current (P.W. = 100 μs max) I _{pulse} (mA)	Forward Breakdown Voltage Range V _{(BR)F} (Volts)	Forward Breakover Current I _{(BR)F} (mA)	Differential Voltage Range I _F = 10 mA ΔV (Volts)	Ambient Operating Temperature T _A (°C)	Package Configuration
309	100	150	19-25	1	6-12	80	TO-18

SILICON

GENERAL PURPOSE

Minimum Ratings and Characteristics (unless noted)										
HEP Type #	Typical Collector-Base Voltage BV _{CBO} (Vdc)	Minimum Collector-Emitter Voltage BV _{CEO} (Vdc)	Minimum Emitter-Base Voltage BV _{EBO} (Vdc)	Typical Collector-Current I _C (mAdc)	Total Device Dissipation @ T _A = 25°C P _D (mW)	Operating Junction Temperature T _J (°C) Max	Typical Cut-Off Frequency f _{hfb} (MHz)	Typical Current Gain h _{fe} (β)	Device Polarity	Package Configuration
50	12	10	4	100	300	+175 ↓	100	80	NPN	TO-18
51	20	20	4	500	600		50	80	PNP	TO-5
52	10	6	4	100	300		100	80	PNP	TO-18
53	12	10	4	500	600		50	80	NPN	TO-5
54	30	20	5	200	310	+135 ↓	30	180	NPN	TO-92
55	30	25	5	200	310		200	100	NPN	TO-92
56	30	20	2.5	100	310		750	70	NPN	TO-92
57	25	25	5	200	310		200	120	PNP	TO-92

UNIUNCTION

Maximum Ratings and Characteristics (unless noted) @ 25°C. Modified TO-18 package.										
HEP Type #	RMS Emitter Current (mA)	Intrinsic Standoff Ratio η @ $V_{BB} = 10\text{ V}$		R_{BBO} $V_{BB} = 3\text{ V}, I_E = 0$ (k Ω)		Interbase Voltage (Volts)	RMS Power Dissipation (mW)	Operating Junction Temperature T_J (°C)	Emitter Rev Current I_{EO} @ $V_{BE} = 30\text{ V},$ $I_B = 0$ (mA)	Minimum Valley Current I_V @ $V_{BB} = 20\text{ V},$ $R_{B2} = 100\ \Omega$ (mA)
		Min	Max	Min	Max					
310	50	0.66	0.80	4.7	9.1	35	300 ②	-65 to +125	12	4

② Derate 3 mW/°C ambient temperature increase

BILATERAL TRIGGER

Maximum Ratings and Characteristics (unless noted) T _A = 50°C										
HEP Type #	Peak Pulse Current I _{pulse} (Amps)	Typical Breakover Voltage		Breakover Current		Minimum Breakback Voltages		Total Device Dissipation P _D (mW)	Operating Junction Temperature T _J (°C)	Package Configuration
		Forward Switching V _{(BR)F} (Volts)	Reverse Switching V _{(BR)R} (Volts)	Forward Switching I _{(BR)F} (μAmp)	Reverse Switching I _{(BR)R} (μAmp)	Forward ΔV _F (Volts)	Reverse ΔV _R (Volts)			
311	2	35 ±3	35 ±3	150	150	6	6	150	-65 to +150	DO-7

ZENER DIODES

GLASS REFERENCE ELEMENTS

Maximum Ratings and Characteristics (unless noted) $\pm 20\%$						
HEP Type #	Nominal Zener Voltage $V_Z @ I_{ZT}$ (Volts)	Test Current I_{ZT} (mA)	Zener Impedance $Z_{ZT} @ I_{ZT}$ (Ohms)	DC Zener Current I_{ZM} (mA)	Device Power Dissipation (room temp) P_D (mW)	Package Configuration
101①	10	12.5	8.5	3.2	400	51

① $\pm 20\%$ Tolerance

SURMETIC† REFERENCE ELEMENTS

102①	3.6	69	11	252	1 W	59
103①	6.2	41	3	146	1 W	59
104①	9.1	28	6	100	1 W	59
105①	12.0	21	10	76	1 W	59

① $\pm 10\%$ Tolerance

SILICON RECTIFIERS

STUD MOUNTED

Maximum Ratings and Characteristics (unless noted)							
HEP Type #	Peak Reverse Voltage V_{RM} (Volts)	RMS Reverse Voltage V_R (Volts)	Average Rectified Forward Current (Half-Wave) I_O (Amps)	Peak Repetitive Forward Current $I_{FM(rep)}$ (Amps)	Non-Repetitive Peak Surge Current $I_{FM(surge)}$ (Amps)	Operating and Storage Junction Temperature Range T_J, T_{stg} (°C)	Package Configuration
151	50	35	15 ①	50 ②	250 ②	-65 to +175	42
153	200	140	15 ①	50 ②	250 ②	-65 to +175	42

① 60 Hz @ $T_C = 150^\circ\text{C}$

② 60 Hz @ $T_C = 25^\circ\text{C}$

MINIATURE AXIAL LEAD SURMETIC†

Maximum Ratings and Characteristics (60 Hz Sinusoidal)						-65 to +175 ↓	59
154	50	35	1 ③	10	30 ④		
156	200	140	1 ③	10	30 ④		
157	400	280	1 ③	10	30 ④		
158	600	420	1 ③	10	30 ④		
159	800	560	1 ③	10	30 ④		
160	1000	700	1 ③	10	30 ④		

③ 75°C Ambient

④ 1/2 cycle surge, 60 Hz

METAL CASE, AXIAL LEADS

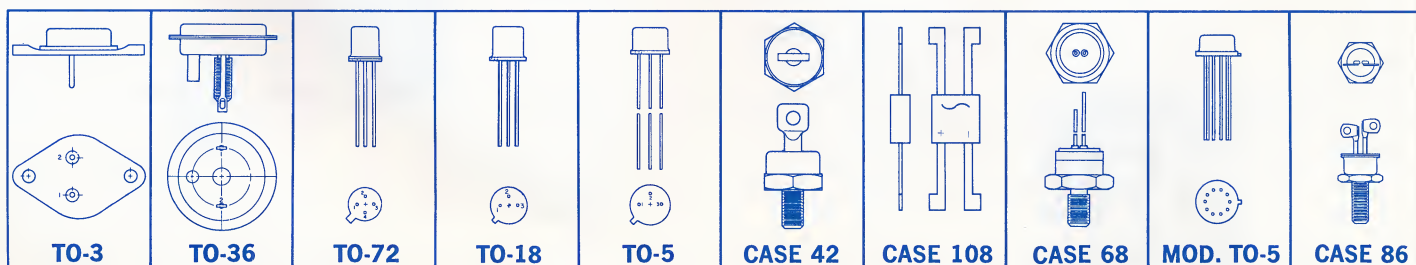
Maximum Ratings and Characteristics (T _A = 25°C unless noted)							
161	50	35	3 ⑤	25 ⑥	300 ⑥	-65 to +175	60
162	200	140	3 ⑤	25 ⑥	300 ⑥	-65 to +175	60

⑤ 60 Hz, 1 ϕ , $T_A = 75^\circ\text{C}$

⑥ $T_A = 75^\circ\text{C}$

†“Surmetic” is a Motorola trademarked term denoting all devices using a special technique to achieve high reliability and greater surge handling capability.

CASES



THYRISTORS (SILICON CONTROLLED RECTIFIERS)

STUD MOUNTED

Maximum Ratings and Characteristics (unless noted) @ $T_J = 100^\circ\text{C}$												
HEP Type #	Peak Reverse Voltage V_{RM} (Volts)	Peak Gate Voltage		Forward Current RMS (all conduction angles) I_F (Amps)	Gate Trigger Current I_{GT} (mA)	Operating Temperature Range T_J ($^\circ\text{C}$)	Surge Current (1/2 cycle 60 Hz) I_{surge} (Amps)	Forward "ON" Voltage (Typ.) V_F (Volts)	Holding Current (Typ.) I_{HO} (mA)	Hex Stud Size (inches)	Stud Torque (in/lbs)	Package Configuration
		Fwd V_{GFM} (Volts)	Rev V_{GRM} (Volts)									
300	50	10	10	5	30 ②	-40 to +100	80	1.3 ②	10 ②	7/16	15	86
301 ①	50	10	10	5	30 ②		80			7/16	15	86
302	200	10	10	5	30 ②		80			7/16	15	86
303 ①	200	10	10	5	30 ②		80			7/16	15	86
304	50	10	10	15	50 ②		200			11/16	30	68
305 ①	50	10	10	15	50 ②		200			11/16	30	68
306	200	10	10	15	50 ②		200			11/16	30	68
307 ①	200	10	10	15	50 ②		200			11/16	30	68

① Reverse Polarity

② $T_J = 25^\circ\text{C}$

FULL WAVE BRIDGE RECTIFIERS

SINGLE PHASE

Maximum Ratings and Characteristics (unless noted)								
HEP Type #	Peak Reverse Voltage (per cell) V_{RM} (Volts)	RMS Input Voltage V_{IN} (Volts)	DC Output Voltage V_{OUT}		DC Output Current @ 75°C Amb I_{OUT} (Amps)	Peak Repetitive Forward Current $I_{FM(rep)}$ (Amps)	Non-Repetitive Peak Surge Current $I_{FM(surge)}$ (Amps)	Package Configuration
			Res. Load (Volts)	Cap. Load (Volts)				
175	50	35	30	50	1	5	32	108
176	200	140	124	200	1	5	32	108
177	400	280	250	400	1	5	32	108

INTEGRATED CIRCUITS

CURRENT MODE

Maximum Ratings and Characteristics (unless noted)					
HEP Type #	Power Supply Voltage (Volts)	Logic Function	Typical Fan-Out	Typical Propagation Time (ns)	Package Configuration
553	8	Half-Adder	5	15	TO-5 ③
554	8	Bias Driver	5	15	TO-5 ③
556	8	3-Input Gate	5	15	TO-5 ③
558	8	JK Flip-Flop	5	15	TO-5 ③

③ Modified TO-5 package for 10 pin

FIELD EFFECT TRANSISTORS

N CHANNEL

Maximum Ratings and Characteristics ($T_A = 25^\circ\text{C}$)									
HEP Type #	Trans-conductance (μMHOs)	Drain-Source Voltage V_{DS} (Vdc)	Drain Current I_D (mA)	Gate-Source Breakdown Voltage $V_{(BR)GSS}$ (Vdc)	Gate Reverse Current I_{GSS} (nA)	Zero-Gate Voltage Drain Current I_{DSS} (mA)	Total Device Dissipation P_D (mW)	Operating Junction Temperature T_J ($^\circ\text{C}$)	Package Configuration
801	3000 Min	20	15	-20	-1.0	0.5 to 15 ③	200 ④	125	TO-72

③ Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle $\leq 10\%$;

④ Derate 2 mW per $^\circ\text{C}$ above $T_A = 25^\circ\text{C}$

CASE 51 (DO-7)

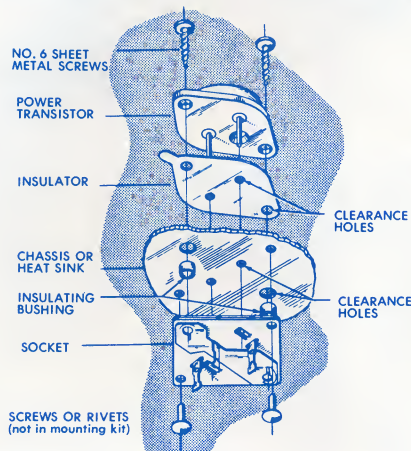
CASE 59

CASE 60

TO-92

ACCESSORIES

POWER TRANSISTOR MOUNTING KIT

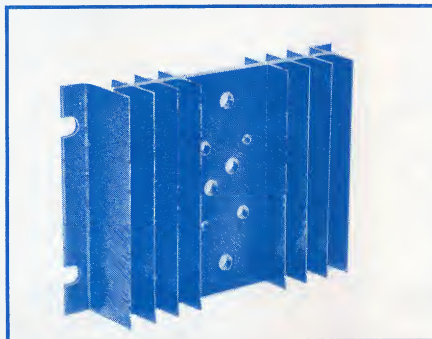


HEP 450

Provides a dependable and efficient method for mounting all TO-3 transistor types. Features ease of removal and replacement while maintaining complete heat transfer characteristics.

HEAT SINKS

HEP 500 (TO-3 configuration)



Provides adequate power transistor cooling by conduction, convection, and radiation. Measuring only 4-1/2" X 3-1/16", has thermal dissipation equal to that of a flat sheet of aluminum 10" X 8" X 1/8".

HEP 501 (TO-36 configuration)



TYPICAL PROJECTS

USING INEXPENSIVE MOTOROLA SEMICONDUCTOR PRODUCTS

LOW-COST INTERCOMMUNICATION SYSTEM

The numerous applications for intercoms throughout the home are making them almost as common a sight in the average kitchen as the popular table radio. With it, you can monitor baby in the nursery or communicate with someone in the garage, basement, barn, etc. In fact, the intercom provides a simple economical solution where communication between two points is needed. It is particularly useful for communication between a truck cab and camper or between car and house trailer. It can be operated from the ac line current or by batteries.

DC VOLTMETER

A rugged piece of test equipment is the DC Voltmeter utilizing Field Effect Transistors. Its high (22 megaohm) input impedance and scale accuracy ($\pm 2\%$ of full scale reading) offers a valuable tool in measurement. Completely portable, its individually calibrated ranges eliminate re-zeroing when changing ranges.

ORGAN, ELECTRONIC STRING GUITAR

These fascinating projects result in "black boxes" that reproduce the tones of their namesake musical instruments. Both are self-contained, battery powered. The organ features a 4-octave range, a vibrato effect and separate voicing controls. The Guitar is "fretted" and has its own built in amplifier and speaker system. Both utilize integrated circuits.

REGULATED POWER SUPPLY

This is a general purpose power supply that furnishes a well filtered stable voltage in the 9 to 10-volt range. It is suitable for use with most any transistor circuit that requires a voltage of 9 to 10 volts and currents up to 250 milliamperes.

HI-FI PREAMPLIFIER

The linear frequency of this HEP preamp is 20Hz to 40KHz, and features high input impedance and emitter-follower output. This project utilizes field effect transistors (FETs) in the amplification and tone control circuits and compares with units selling in the \$80.00 to \$100.00 range.

FOUR-INPUT AUDIO MIXER, PREAMPLIFIER

For Hi-Fi, guitar amps, and PA systems the HEP audio-mixer offers a flat frequency response in the range from 20Hz to over 100KHz. Features hi-input impedance and low impedance emitter-follower output. Two inputs can be utilized simultaneously for stereo and the completed system compares to ready made units in the \$50.00 price range.

MOTOR SPEED CONTROL

Control the operating speed of almost any portable shop tool or kitchen appliance, using a standard series universal dc motor, with this simple, inexpensive SCR motor speed control. This speed controller works with fans, movie projectors, sewing machines, drills, saber saws etc. The motor speed controller can also be applied as a lamp dimmer with incandescent lamps or to control the temperature of soldering irons.

SQUARE WAVE GENERATOR

Build your own piece of test equipment that features a 10 nanosecond rise time and frequency response of 6Hz to 60KHz in four ranges. It is battery powered and completely portable. By using a simple adapter it can operate from the normal power line. With its emitter-follower low impedance output it out-performs any commercially built square wave generator in the \$150.00 to \$200.00 price range.



NOW AVAILABLE A COMPLETE TECHNICAL LIBRARY

Now available to the hobbyist, experimenter and professional ... a complete technical library.

If you're interested in the dynamic art of solid state electronics, take a look at the new technical information library now available through Motorola's HEP program. This is the program for hobbyist, experimenter and professional use that has something for everyone -- from beginner to expert.

Not only does HEP provide quality solid state devices that reflect the LATEST in semiconductor advances, it also offers a complete library on how to use these devices. Included in the library is:

INTEGRATED CIRCUIT PROJECTS FROM MOTOROLA - Eight chapters including a basic introduction to integrated circuits as well as interesting projects using integrated circuits.

FIELD EFFECT TRANSISTOR PROJECTS - Ninety-six pages of information and projects built around the Field Effect Transistor.

SOLID STATE PROJECTS FROM MOTOROLA - Ten chapters, including one on semiconductor fundamentals. Projects cover wide applications and include test equipment, intercom, motor speed control and novelty circuits, and five technical handbooks covering all aspects of the lively and growing Solid State art. These handbooks are, according to thousands of engineers throughout the world, now becoming standard references in the electronics industry.

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